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ABSTRACT

The purpose of this study was to identify the central values and the range of variability for costs associated with selecting and preparing books for microfilm preservation, filming, and maintaining quality control and adequate records. The study was based on data supplied by the libraries at the University of Chicago and Columbia University, the New York Public Library Research Libraries, and the Library of Congress, as well as site visits to each library, interviews with key personnel, detailed work logs kept during the first six months of 1986, and work sampling data collected during the same period. Considerable variation was found in the unit costs of the library-specific processes of decision making and preparation and review, with smaller variations in the costs of the film work itself. The data suggest that the path to greater efficiency is in the development of large processing centers, with careful attention to the problems of record management and administration. (CGD)

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Costs of Preservation Microfilming at Research Libraries:

A Study of Four Institutions

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November 1986

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COSTS OF MICROFILM PRESERVATION AT RESEARCH LIBRARIES: A STUDY OF FOUR INSTITUTIONS

Paul B. Kantor

ABSTRACT

Costs associated with microfilm processing have been studied at the libraries of the University of Chicago, Columbia University, the New York Public Library Research Libraries, and the Library of Congress. The purpose of this study is to identify central values and the range of variability for costs associated with selecting books for microfilm preservation, preparing them for microfilm preservation, filming, and maintaining quality control and adequate records. The study has been based upon data supplied by the libraries, site visits to each library, interviews with key personnel, detailed work logs kept during the first six months of 1986, and work sampling data collected during the same period. We find considerable variation in the unit costs of the library-specific processes of decision making and preparation and review, with smaller variations in the costs of the film work itself. The data suggest that the path to greater efficiency is in the development of large processing centers, with careful attention to the problems of record management and administration.

This work was performed under contract to the Council on Library Resources. Contract Officer: Dr. Martin Cummings.

EXECUTIVE SUMMARY

We have studied the labor component of the costs associated with preservation microfilming. We summarize the large variation in costs by representative figures for each of the key processes. (Details are in Section 6.1) Data are for a nominal 240p book.

Activity	Minutes	
(1) Decision/search	5.0	Some prof time (a)
(2)a. P x P collate	16.3	(240/14.7)
b. Disbind	2.0	min
(3) Record keeping	14.0	60% (1)-(2)
(4) Targets	8.0	
(5) Filming	30.0	240/(2x4 exp/min)
(6) Processing	10.8	17% of (5)+(6)+(7)
(7) Quality control	22.7	min/title (one library)
(8) Administration	38.08	nominal at 35% of cost of (1)-(7)
	146.9	

To convert this to a cost we designate an hourly wage of $10/hour. This is higher than the data reported at the university libraries and lower than the data at the other libraries.

$$146.9/60 \times 10 = \$24.48$$

Our analysis suggests that with large volume cooperative microfilming the task costs could be reduced by at least 10.5%. (Section 7.1). We find that 35% of all costs are for record-keeping and administration, and estimate that they could be reduced by at least 8%. (Section 7.2). The overall potential savings in labor is $4.53 per 240 page book.

We have assumed that costs of supplies and chemicals are uniform across the libraries. All libraries use paid-up equipment, and costs of maintenance have not been determined. Possible labor savings from the use of newer technology are discussed in Section 7.3.

The results of this study support the idea that preservation microfilming should be done in large volume, with careful attention, at the outset, to controlling the costs of record-keeping and administration.

Figure 1. The distribution of labor expense. The distribution of labor expense, based upon work sampling data, is shown for the seven direct tasks involved in preservation microfilming. Data on filming were not available at all libraries, and one library served as link to assign the relative proportion of preparation and filming tasks.

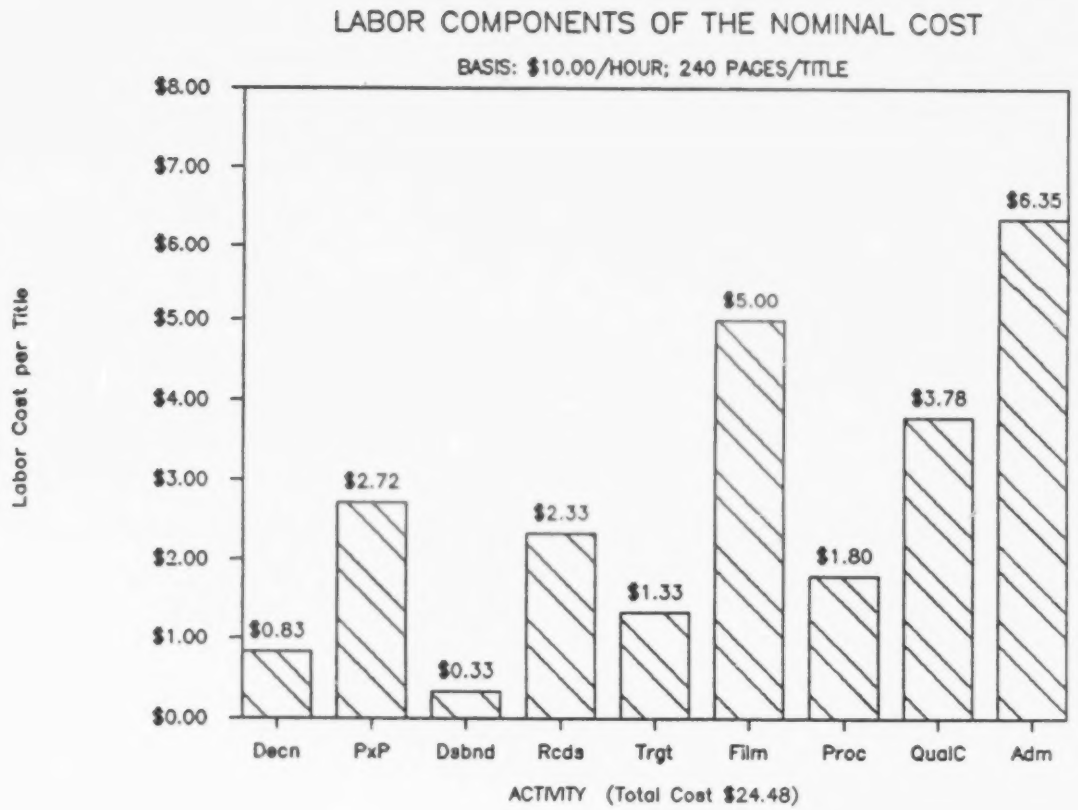

Figure 2. Components of the nominal cost. Using representative figures for all of the tasks, including record-keeping and administration, a nominal cost was determined for a 240 page book. Details are given in Section 6. As with all data based upon work logs, these cost estimates are subject to revision based upon the true wage rate, per productive hour, in the workplace.

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1. INTRODUCTION

1.1 The Preservation Problem

The research libraries of America contain many books printed on paper that is rapidly deteriorating because of its acid content. For future researchers and for archival purposes, it is essential to preserve the intellectual content, the graphic and plate images, and some sense of the design of each such book. If a book is heavily used it will presumably be reprinted, so, the subject is those books of value whose value does not lie in heavy use. The best currently available solution is preservation microfilming (PM) with a master negative from which positive prints are prepared for the holding library, and for any other users around the country. The cost of preparing such a positive print is usually less than the purchase price of a current book.

Several studies have established that books printed during the period when the manufacture of paper left residues of acid are deteriorating rapidly in the nation's research libraries. Some studies have estimated that as much as one third of the collections in the older major research libraries is subject to this problem. When one examines these books at first hand, the problem is apparent. Although a given page is generally readable, it will be deteriorated in one of two ways. Hard finish, thin paper becomes extremely brittle and brown around the edges. When folded three or four times (in bad cases even when folded once), the paper snaps cleanly along the fold and part of the page will be easily lost. The condition of books with a thick pulpy paper is even less manageable. In this case, the paper separates almost spontaneously under tensile stress. Thus, it is common to find that one or two hundred pages of the book will have separated from the binding at a point close to the binding. Essentially, the full contents of the book are in danger of being lost.

For several decades the recognized means of preserving the content of these "brittle books" has been photographic preservation on microfilm. This preservation makes the content and even such details as the page layout of the books available to future scholars. For all but the most important books, once the contents have been filmed, the book is discarded.

The national effort to preserve threatened books by microfilming involves some problems specific to any participating library, such as the selection of books for preservation, their preparation for preservation, the preparation of new catalog entries, corresponding to the new physical form, the filming, and final quality checks before the book itself is discarded.

Other problems are related to the fact that microfilm preservation is a national enterprise, with implicit interdependence. When an item is preserved in microfilm, the sooner the fact that it has been preserved is readily available to other libraries, the less duplication of effort there will be in deciding whether to film it, or in filming it. From film there are well established processes for making duplicates at varying levels of quality. These may be either film or paper copies, and can serve the needs of libraries that have discarded their own copies of the deteriorated item. All other libraries thus rely on the original microfilming to meet adequate standards of readability and longevity.

With the current wave of technological expectations, there is reason to hope that in the not too distant future it will be possible for all but the most deteriorated books to be scanned by some kind of computer-based device that will identify the individual letters, and reduce the text to the kind of electronic form used in current publishing. Even before that is possible, it is quite likely that developments in video disk technology will replace the optical technology (which is little changed during the last three decades) with an electronic method which is efficient, although not digitized. All of these methods promise to achieve adequate quality for text and graphic material, if not prints and photographs. Electronic methods will provide substantial improvements in retrieval and duplication.

1.2 This Study

The purpose of this study is to look at the costs of several PM operations in widely varying settings. To do this we identify 8 conceptual components that are found in every complete PM operation: (1) The decision to microfilm, with supporting searching (2) Physical preparation of the book for filming (3) Associated record keeping (4) Preparation of "targets" - inserts that are filmed to provide identification on the film, including large images that are readable unaided, on a microfilm or microfiche (5) Filming (6) Processing of the film (7) Quality control checks of the film for resolution, contrast, satisfactory chemical composition, and bibliographic integrity (pages in order, etc) (8) Administrative support.

This study has addressed the question of proceeding as efficiently as possible with that photographic preservation that must continue to take place, in a race with deteriorating books, until such time as the anticipated electronic technologies are available.

The motivation for a study of a process that will, in the long view , be replaced by newer technology is to make the best

possible use of current resources. There is reason to anticipate possible savings in labor costs because of the known variability of such costs in comparable library operations.

Numerous studies, both in the United States and England, have shown variations of as much as a factor of four in the cost of performing what appears the same activity at various libraries. This is not surprising, in view of the fact that libraries do not operate in a consumer market, with factors of price competition. Each library is an empire unto itself, competing with others only in its effort to obtain rare materials and capable staff. Since the competition for staff is more likely to be based on factors of salary and working conditions, than on the efficiency of library operations, there is really no force tending to equilibrate efficiency across the research libraries of the nation.

It is therefore clear that if a comparative study of several major libraries focuses on functionally equivalent tasks, it may identify that library or those libraries at which those tasks are being done in a particularly efficient manner. When the name of the efficient library is made known one hopes that other libraries will, through visits or other communication, master the efficiencies and lower their own costs.

The four libraries involved in this study agreed to cooperate on the condition that results would be almost completely confidential. The only exception is that, for each process, we will name the library which appears to have the lowest cost.

In order to comply with this restriction, we must present data in forms which are somewhat unconventional. For example, we cannot present a table showing cost for each process for each library even if the libraries are anonymous in that table. By reference to the name of the library having the lowest cost for some task one would learn the cost for all other processes at that library, some of which might be high.

The reader is reminded that there is no mechanical way to sum the costs for various parts of this process to obtain a total cost for "selecting and preserving a book". Books vary in their size, shape and physical condition. The record keeping requirements and the search requirements vary from book to book. Since microfilm preservation is, at its foundation, the management of several million separate cases, this result is not surprising. Nonetheless, it may be possible, by sharing of procedures and techniques to save as much as 10% of the cost of microfilm preservation.

Although it is somewhat aside from the major thrust of this report, we note that library officers involved with preservation

microfilming are highly self-aware, and have already formed a special interest discussion group which meets in conjunction with the annual meeting of the American Library Association. This group provides an ideal forum for the sharing of information on cost effective policies, procedures and technology. For it to lead to cost reductions, library directors may have to apply a certain amount of friendly persuasion, so that cost saving is balanced against the more common imperative of obtaining further funding, in the management of preservation.

1.3 Key findings

The profile of relative costs is quite similar at four very different libraries - The University of Chicago, Columbia, New York Public Library - Research Library, and the Library of Congress. The difference in size is shown by the annual direct salary for preservation.

Table 1. Total Salary Data for Some Components of the libraries

University of Chicago	(1) Small + (3-8)	200,000
Columbia University	(1-8)	253,000
New York Public Lib.	(1-8)	550,000
Library of Congress	(1-4)	436,000

The profiles of salary expense are summarized for preparation and for filming separately in Table 2.

Table 2. Profile of Salary Expense: Preparation and Filming

Tasks (1-4)	(1)	(2)	(3)	(4)
Proportion	15%	36%	43%	6%
Std Deviation	3	8	11	1

Tasks (5-7)	(5)	(6)	(7)
Proportion	56	17	28
Std Deviation	2	5	6

For example, Task (2) - physical preparation, represents 36% of all the salary expense prior to filming.

The data on efforts and management expenses is summarized in Table 3.

Table 3. Effort Ranges and Management Rates

Task		
1. Decisions with searching	2.29-7.82	min/item
or Preservation review	14.6	min/item
2. Page by page collation	14.9-14.5	p/min
Disbinding	1.2 - 7.0	min/book
3. Record keeping	44%-143%	of costs (1)+(2)
4. Targets	3.5-24.6	min/item
5. Filming	5.95-2.12	exp/min
6. Processing	12%-22%	of total film lab costs
7. Quality Control	22.7	min/title (one library)
Page checks	14.5-21.9	pages/min (two librarians)
8. Admin. overhead	16%-64%	of costs (1)-(7)

For example, record keeping effort represents 44 to 143 percent of the total effort for tasks (1) and (2)

By a series of bold assumptions (see section 6), specifically a mean wage of $10.00 per hour for non-professional personnel, and an assumed 240 page "book," we arrive at an estimate of $24.48 for the selection, preparation, filming and checking of a single book. This does not include the costs of cataloging required by the change in format, or by obsolescence of the original catalog record. Direct costs, such as film and chemicals are not included, nor are capital costs.

In reviewing possible areas for cost savings we are led to the general conclusion that management is more significant than the direct "touch" labor. Specifically, record-keeping, which is the management of information, and administration, which is the management of work, contribute over 35% of the total cost. We suggest that the path to greater efficiency is in the development of large processing centers, with careful attention to the problems of record management and administration.

2. THE LIBRARIES

2.1 University of Chicago

The University of Chicago Regenstein Library combines an old and well-established microfilm operation, with a very new (initiated in the academic year 1985-86) microfilm preservation effort. The problems of preservation have been ingeniously integrated with the broader problem of book selection, through policies introduced by the head of collection management, and by the director of the libraries.

In this study, the University of Chicago contributed only preliminary data on the costs of decision making. However, the microfilm lab provided a substantial amount of data, based on its involvement in a large project for the American Theological Libraries Association, which occurred during the span of the study.

2.2 Columbia University Libraries

The Columbia University Libraries maintain an integrated microfilm operation, in which physical preparation and filming are in continual interaction with the main and departmental libraries, from which they receive a steady flow of materials for processing.

During the time of the study, the Columbia University Libraries were in an atypical situation, as the director of the film processing lab had just moved to another position and was not replaced during the time of data collection. In spite of this unusual situation, the Columbia University Libraries provided the only example of a continuous flow, and have served as the sole basis for our estimate of the relative proportions of preparation cost to filming cost in such an operation.

2.3 New York Public Library - Research Libraries

The New York Public Library - Research Libraries maintains a large preservation operation, whose scope has recently been expanded to include the micro-photographic film lab. The film lab also serves other library needs, so that the flow of materials is not as clearly integrated as that at Columbia University.

The New York Public Library operation is divided broadly into the preparation stages (the preservation microfilming office), the photographic aspects (the film lab), and various post-microfilming activities, which take place in an office that also handles the processing of requests for copies of microform material.

2.4 The Library of Congress

At the Library of Congress the filming operation is a distinct unit, with an independent budget. The microfilm preservation office prepares materials and ships them to the film lab much as it would ship to an external contractor. Materials are returned from the film lab, not to the office from which they came, but to a third part of the library, the microfilm reading room, where they are double checked for image quality.

During the time of this study, the Library of Congress was under severe pressure due to the budget reductions imposed by the Gramm-Rudman-Hollings Act. Nonetheless, the microfilm preservation office participated fully in all aspects of the study, and the microfilm reading room provided work logs on the activities of interest.

The filming lab did not provide data in the standard forms used at other libraries in this study. However, since it is required to support itself, including all of its overhead charges for administrative expenses, we are quite satisfied that the costs reported to us are at least as accurate as those that we have been able to obtain at the other libraries participating in this study.

3. METHODOLOGY

3.1 Work Sampling (W) - Profiles of Effort and Expense

Work sampling is a technique widely used in industry to study the work of people who must divide their time between many tasks. In work sampling, an observer looks into the work area on a random schedule, and notes what each of the workers is doing. The principle is extremely simple: if, on 30% of those occasions, Jack Smith is observed to be doing task B, we conclude that on the average, Jack Smith spends 30% of his time doing task B. This contributes an effort figure of 0.3 FTE to the effort profile and three tenths of Mr. Smith's annual salary to the labor expense profile. The full profile is obtained by combining the allocations of all people who are observed to be doing, for example, task B. A typical data collection form is shown in Exhibit 1. At each library, codes were assigned to each worker so that, during data processing, the tallies could be separated and each combined with the appropriate wage. A typical table for the combination of effort and wage data is shown in Exhibit 2.

Work sampling provides the best information we have on the relative proportion of the cost attributable to various activities, the "cost profile."

3.2 Time Logs (T) - Effort per Item

For the determination of costs per item produced, we have resorted to the (not entirely satisfactory) technique of work logs. In a work log (an example is shown in Exhibit 3), the worker notes each day the number of items completed, and the approximate number of hours spent to complete those items.

The well known difficulty with work logs is that a certain amount of time cannot be accounted for, particularly in situations where staff are involved in tasks unrelated to this study. This problem has been controlled by cross-checking the work logs against the work sampling study. The data are found to be in good agreement with each other, and with available data from the libraries themselves.

3.3 Error Analysis (E) - Role of Collation/quality control

Although all participating libraries keep logs of errors detected on the film, which serve as a guide for "retakes" of damaged or missing pages, we gave particular attention to the nature of the errors detected during the collation process. Data were gathered on a simple standard form, with a space to record the amount of time required to resolve the problem. Although the sample of data is very small, it gives us some indication of the

nature of problems detected during the collation process, and of the time required to resolve those problems. The results are summarized in Section 5.

3.4 Data Supplied by the Libraries (L)

Each library provided some of its usual statistics on productivity. We have not generally relied upon these for our analysis of unit cost, because we could not be certain of variations in local definition. However, in some cases, these data have been used to provide an estimate of the relative magnitude of those parts of the activity that we were unable to study by work sampling.

Monday Feb 24, 1986

	Actual	Decisn	PhysPrp	Records	Target	Filmng	Process	Quality	Admin	Extnl
08:15 AM										
08:30 AM										
08:46 AM										
09:49 AM										
10:35 AM										
01:12 PM										
01:45 PM	2:00	A	BeD		Bo			C	J	EL

Wednesday Feb 26, 1986

10:07 AM										

Form 1. Instructions.

This form is used to sample the activities of people working in microfilm preservation, so that we can pick up some of the time that gets "lost in the cracks." It is easy to use, and requires only a few seconds - perhaps a minute and a half, each time that you use it.

The columns are headed with "code words" representing the varied activities in microfilm preservation. The first column is for the actual time of the sample. The others are for:

DECSN: Decsion making activities and their support. This includes selection decisions, and supporting activities such as searching for other copies.
PHYS PRP: Physical preparation, such as debinding, collation and so forth. This includes both quality check work and mechanical processing of the book or other item.
RCRDS: Record-keeping of all kinds: preparation of the in-process work papers, and maintenance of catalogs and other files.

The next four columns refer to technical processes:
TARGET: Preparation of the target, and other set-up for filming
FILMING: Self-explanatory. Includes fetching items to film and so forth.
PROCESS: Processing film, to make negatives, to develop, to print positives, and to splice in correction frames.
QUALITY: Technical aspects of quality control. Checking resolution, contrast, and the alignment of pages on the film.

The last two columns are more general in nature.
ADMIN: All types of administrative activity, including training and committee meetings.
XTRNL: Any work that is done for purposes other than microfilm preservation. ALSO use this column to record personal time such as coffee break, or lunch. If someone is absent, record the fact in this column.

The people working in the microfilm preservation area are each given a code letter, in the table at the right. Most of the codes are easy to remember (they are initials.) Some are not so easy, but only a few.

Instead of using strictly random sampling, we have selected some days (at random), and then some hours during those days. The attached calendar will help you to keep track of the selected days. At the start of each day, make a note of the sampling times.

Exhibit 1. Sample data collection form for work sampling.
This is an extract from the book of data collection forms that was sent to each library, with suggested dates and times for data collection. The key instructions are reproduced in the insert. The example data in the line for 2/24/86 1:45 pm show that the observation was made at 2:00; that the person with code "A" was involved in decision making; those with codes "Be" and "D" were doing physical preparation, and so on.

800 : Student hrs / year | PERSON.PRN data

	Name	Salary/Yr	RowSum	id	1 Decisn	2 PhysPrp	3 Records	4 Target	5 Filang	6 Process	7 Quality	8 Admin
1	C	7,407.00	12	1	0	9	3	0	0	0	0	0
2	Je	15,751.00	29	2	9	0	20	0	0	0	0	0
3	Ju	17,106.00	23	3	0	4	15	0	0	0	0	4
4	L	14,842.00	21	4	3	10	8	0	0	0	0	0
5	M	14,842.00	23	5	0	6	15	2	0	0	0	0
6	P	17,106.00	36	6	12	11	10	0	0	0	0	3
7	R	8,567.00	16	7	1	0	15	0	0	0	0	0
8	S	25,685.00	41	8	1	0	3	0	0	0	0	37
9	T	13,966.00	7	9	1	0	6	0	0	0	0	0
[illegible]		[illegible]	18	10	5	4	[illegible]	0	0	0	0	[illegible]
30	Z	[illegible]	0	11	0	[illegible]	0	0	0	0	0	0
		Total # of lines =	44									
Sum		$150,114.00	226		32	44	104	2	0	0	0	44
Average					0.73	1.00	2.36	0.05	0.00	0.00	0.00	1.00

SALARY SHARE

1 Decisn	2 PhysPrp	3 Records	4 Target	5 Filang	6 Process	7 Quality	8 Admin	EXCLUDE
0.00	1,515.07	505.02	0.00	0.00	0.00	0.00	0.00	5,386.91
3,221.80	0.00	7,159.55	0.00	0.00	0.00	0.00	0.00	5,369.66
0.00	1,555.09	5,831.59	0.00	0.00	0.00	0.00	1,555.09	8,164.23
1,011.95	3,373.18	2,698.55	0.00	0.00	0.00	0.00	0.00	7,758.32
0.00	2,023.91	5,059.77	674.64	0.00	0.00	0.00	0.00	7,083.68
4,665.27	4,276.50	3,887.73	0.00	0.00	0.00	0.00	1,166.32	3,110.18
194.70	0.00	2,920.57	0.00	0.00	0.00	0.00	0.00	5,451.73
583.75	0.00	1,751.25	0.00	0.00	[illegible]	0.00	21,598.75	1,751.25
317.41	0.00	1,904.45	0.00	[illegible]	0.00	0.00	[illegible]	11,744.14
1,686.59	1,349.27	3,035.86	0.00	[illegible]	0.00	0.00	0.00	[illegible]
[illegible]	[illegible]	0.00	[illegible]	[illegible]	0.00	0.00	0.00	[illegible]
0.00	[illegible]	[illegible]	[illegible]	0.00	0.00	0.00	0.00	0.00
$11,681.48	$14,093.02	$34,754.34	$674.64	$0.00	$0.00	$0.00	$24,320.16	$64,590.36
7.78%	9.39%	23.15%	0.45%	0.00%	0.00%	0.00%	16.20%	43.03%

Exhibit 2. Processed data from work sampling

Data were processed in two steps. First the data from the collection sheets were cumulated into tables. These (PERSON.PRN) files show the number of times that each code was reported at each activity. The average, at the foot of the table, gives the average number of average FTE observed doing the corresponding task.

The effective annual salary, excluding fringe, was combined with this data for the second part of the analysis. This table (SALARY SHARE) shows the corresponding annual direct labor cost for the activities, and expresses them as percentages of the total of the direct labor costs. Note that there can be a large portion (43.03% in this example) corresponding to excluded time, representing either work outside the scope of this project, or inter-task time, which is a form of overhead.

4. THE FINDINGS: PROFILE AND EFFORT

4.1 Decisions and Searching

The decision making process is most difficult to quantify because it involves an unpredictable number of reviews. Selection officers, dealing with particular collections, review items and recommend some for filming. Additional review may occur in the preservation microfilming office (PM), based upon either the availability of existing copies (the search aspect of the review) or the impossibility of filming (as in the case of a book that is too rare to be discarded after filming.)

Three of the libraries reported data on the preservation decision making process carried out by collection development officers. The data are:

Decision with regard to filming, including supporting search activity. (From T analysis. These data include all items reviewed for filming, whether the decision was "yes" or "no".)

2.29 5.41 7.82 min/item

One reported only on review in the PM office.

14.6 min/item

The low figure is at the University of Chicago, which has a relatively young collection, and a very new PM program. Selections officers batch their work, while brittle books returned from circulation are reviewed from time to time in the stacks. The collection development officer treats preservation decisions as part of collection development, and each selector is charged $100 against the appropriate book fund, for each book to be searched and filmed.

At the University of Chicago searching for other copies is conducted on a batch basis from time to time. Data on the effort required did not become available during the study.

As described, a second aspect of decision making is the review in the PM office. We have work sampling information on the fraction of PM effort that goes into the decision and search process as it is conducted in the PM office. A profile was formed by expressing the decision-making cost at the PM office as a percentage of the total cost for tasks 1-4. Data are available for three libraries.

Decision to film, including support work (From work sampling (W) analysis)

10.6% 16.4% 18.7%

The low figure, 10.6%, is at the New York Public Library. Major responsibility for decision making is placed on the collection development officers, and review of those recommendations does not consume much time. The PM officer is a leader in the field, and has given considerable attention to educating collection officers with regard to PM.

We have not found a way to integrate these two kinds of data because there is great variation in local practice, and the same kind of work may be done in two different places. In what follows we use only the Time-log data to represent the cost of decision making. This is clearly a lower bound for the libraries studied.

4.2 Preparation

The preparation of materials involves page by page collation of books, replacement of missing pages, cleaning of marked pages, disbinding and, after filming, extraction of plates.

The most comparable data relating to this task are for page by page collation. The data are:

Time for page by page collation (from T analysis; 2 libs)

14.9 14.5 pages/min

The lower figure is at the Library of Congress, where a large staff works at collation. Each worker is at a desk in a partial enclosure, which prevents distraction. However, the figure differs by less than 3% at Columbia, where the work is done at open desks in a large room without dividers.

Data for minutes per title are not readily comparable, since available data show that at the Library of Congress the "average" title during the study period had 550 pages, while at Columbia it had 221 pages.

Data for disbinding (cutting the pages) are available at three libraries.

Time for disbinding:

1.17 5.0 7.0 min/book

The lowest figure is at the NYPL, where disbinding is done by the same people who do collation and other aspects of preparation.

The profile data, for all physical preparation as a fraction of tasks 1-4 are: (from W analysis)

28% 34% 47%

The lowest figure is at the NYPL. The work is done at desks in a large open space, with some tables used for processing work as well.

4.3 Record keeping

Record keeping is regarded as an overhead on tasks (1) and (2). It involves all of the paperwork needed to manage work in progress, and to various aspects of search and decision as they occur. It includes time spent entering and checking data at an RLIN terminal, as appropriate. The figures are available at only three libraries. They are: (from W analysis)

44% 88% 143%

The lowest value is found at the Library of Congress. At the Library of Congress minimal level cataloging is done in the preservation microfilming office, and was not included in this study. It may be, however, that this activity takes the place of some of the record keeping that must be done at other libraries.

The Library of Congress has a computer available in PM for inputting cataloging data and producing cards.

The variation in record keeping, regarded as overhead, is the largest variation found in this study. The importance of full records is stressed at the NYPL, which calls attention to the fact that a cryptic entry may mislead PM officers of the future, who cannot know whether items have been preserved in whole or in part. Thus, there is an obligation to the community, to maintain records that are detailed enough to remain usable as the standards for PM evolve.

4.4 Targets

For preparation of the eye-visible targets the data on effort are: (from T analysis)

3.5 4.5 12.8 24.6 min/item

The corresponding profile data, as a percent of tasks (1-4) is: (from W analysis)

5.0% 5.1% 6.9% 9.4%

The lowest, by either measure, is the Library of Congress.

Primary targets are produced, and card targets are put in order by a GS-4 assisting a GS-5 worker. Eye-visible or "macroscopic" targets are prepared using a Comset machine that cost $28,000 8 years ago (current price $14,000). During its first 5 years of use some 48,000 [1] bibliographic titles were microfilmed. This means that the machine added less than 60 cents to the cost of each title during its 5 year payoff period. The economy of 1.1 min saved, compared to a Leroy lettering set, is justified by the enormous volume.

[1] Based on LC-PMO annual statistics.

4.5 Filming

The effort and, correspondingly, the cost of filming can vary according to the type of material, its condition, and whether it must be kept bound or can be "disbound" (that is, have the back cut off, so that it becomes loose pages) before filming. The "industry standard" is the disbound, brittle book, that is filmed with two pages per exposure.

The data are best expressed in exposures/minute. Data are available both from the time logs (T) and from production statistics provided by the libraries (L). The data are:

Rate of filming

5.95 (L) 5.36 (T) 3.45 (L) 2.12 (T) exp/min

The highest rate was reported at the Library of Congress, and is the average for two workers, both of whom had error rates below 2% for the data reported. The Library of Congress filming unit is part of a stand alone economic unit, which charges LC for its services. Most of the camera operators are highly experienced, and there is a supervisor who sets up and focuses the camera. It was clear to the investigator that the one camera operator observed at work was very fast. It was not possible to view others at work.

The Library of Congress is unionized, and productivity is defined by a detailed table of production rates and task difficulties that were established in 1973.

The profile data are expressed by computing filming salary as a percentage of labor for tasks (5-7). The results are available for 3 libraries and are remarkably uniform.

Filming share of photolab effort:

57% 57% 58%

4.6 Processing

We have profile data (W) for two libraries and library statistics (L) for a third. Processing as a percentage of total filming salary is:

12%(W) 15%(L)* 22%(W) Labor expense

The low figure is at the University of Chicago, where a long established microfilming unit (more than 40 years old) has very recently been joined administratively to the library. The work sampling data were collected at a time when the filming unit was primarily processing old newspapers. The ratio of processing to filming time may of course be different for this type of material.

* The figure of 15% is an upper limit, as the people who do processing also do certain other tasks not relevant to this study.

For the effort involved in quality control our data are not truly comparable, but we summarize the available data

For one library: minutes/title required for

Density check	3.68	
Resolution check	1.62	
Paper work	0.86	
P x P check	16.52	(assuming 240 pages/title
	22.68	min/title

For another library the data are in minutes per reel

Density check	5.84	
Resolution check	5.51	
Paper work	----	
P x P	6.46	
	17.81	min/reel

Since a reel usually contains more than one title these data are definitely lower. They are reported by the University of Chicago, in conjunction with a special project being done for the American Theological Association.

For two libraries, page by page check of film images, page order and placement require:

21.9 14.5 pages/min

The higher production, 21.9 pages/min is reported at the Library of Congress. Two factors must be noted. First, the film has already been subject to one set of quality checks, at the filming

unit. These catch better than 99% of the bad frames, so they do not interrupt the work flow of the page by page check.

Second, at least one of the two scanners at the Library of Congress is able to use a moter driven reader, and can visually track the pages as they move by at a quite dizzying rate.

4.8 Administration

Administrative expenses are described by dividing the administrative salary (as determined from work sampling, augmented by library statistics) by the total of other salary.

Administrative "overhead"

16% 24% 54% 64%

Administrative overhead includes costs of training, personnel management, secretarial costs associated with managing the department, and so on. The lowest rate is at the University of Chicago, which is essentially a filming operation rather than a PM office.

All of the other units had some staff or administrative positions vacant through resignations, death or reductions in force, which may distort the administrative rate.

As with record keeping, the variation is very substantial. Whether high administrative overhead is an unavoidable concomitant of large size, or of a unionized workplace, is a question beyond the scope of this study. In our subsequent discussion we adopt 35% as a representative value for the administrative overhead rate.

5. DATA ON QUALITY

[The study of quality produced the only data collection problem. When the task is to catch errors, good management practice concentrates on the number of errors caught, and not on the number of items scanned. To include both measures in a performance evaluation amounts to setting a de facto quota or target for the number of errors per item, which is not desirable. Hence, at the libraries with the largest available statistical bases, we could not obtain measures for the rate of errors detected against items scanned.]

5.1 The quality impact of collation

Collation is a perplexing task to those who first encounter it. A book is in hand, in whatever condition it may be, and as such has had to serve the needs of those who used it in the past. Why, one asks, should it be cleaned and dressed before it is filmed? The reasons are clear: once a book is filmed, other libraries will assume that it is available in film, and may discard their own deteriorated copies. But if the present copy is incomplete or unreadable, that subsequent discarding is the final loss of the book's contents. So, when a book is to be filmed it should be as complete as reasonably possible. The task of seeing that it is complete is just collation of the pages (or, for some journals, of the issues as a whole.)

We know what page by page collation costs in labor. To estimate its benefits we have sought data on the nature and "magnitude" of the problems that are uncovered. The magnitude is best measured by the amount of time required to resolve the problem.

We found that either very few errors are in fact detected during page by page collation, or reporting was inconsistent. There was probably more benefit to local management than to the study, as one library reported that after reviewing the error records they changed their policy regarding erasures (which represented more than 50% of the special problems noted.) The remainder were problems involving mending of pages, or replacement of missing pages.

Typical times for dealing with misbound pages, missing pages, or pages needing repair range from 15 to 30 min/title. In this study we have not attempted to find the direct costs associated with obtaining a replacement page or copy, should a page be found missing. Direct costs can only be integrated into an overall cost estimate if the "hit rate" for this type of problem is known.

We cannot say, from the available data, what the "hit rate" for these problems is. Thus there is no basis for an economic evaluation of the cost effectiveness of discarding page by page collation.

5.2 The quality impact of film checking

Frame by frame (FxF) checking of film traps errors in page order, placement and focus, and detects damage occuring during film processing. Normally the FxF check is done only once. However, at one of the libraries it is done twice. The second check gives us some information on the chance that an error will get by the first check.

It is clear, from the extensive list of errors found in primary checking of film that primary checking is an essential part of maintaining quality of the product. An error is readily corrected at this stage (a retake, including the internal memorandum or work slip, takes approximately 7 minutes. The splice adds another 5. This is a total of 12 minutes to catch the error, or a cost of approximately $2.00.)

An error in processing, which costs only a few minutes to catch, may render hundreds or even thousands of frames unusable.

When a problem is detected after filming, but within the filming unit, it takes approximately 5 minutes, including notification to the camera operator, to note and report the error. When the units are administratively separate typical figures are 10 minutes to prepare a remake request, and 3.7 minutes to check the corrected film when it arrives. This is a clear example of paperwork overhead. In the separated situation, a request for additional target material, relayed to preservation microfilming, can generate a 20 to 30 minute special task.

We have a small amount of information on the economics of frame by frame checking of film. Such an analysis must balance the total cost of checking against the expected rate of unchecked errors. From data provided by a microfilming unit on the rate of corrections identified in the second check on the film, we find that one in 30 reels had some error. There is no standard measure of pages per reel. Supposing that there are 300 pp per reel, this means that 30x300=9,000 pages are checked for each error that is reported. At the best rate of 21 pp/min this represents 7.14 hours or, with the wage assumption of Section 6, $71.42. The question can then be cast in the following way:

"Is the average impact of the errors detected on secondary review of microfilm large enough in its impact to justify an expense of $71.42 to prevent it?" This sum is larger than the cost

of complete original cataloging at most research libraries, and could cover the acquisition of an inexpensive new addition to the collection.

In sum, film quality control, costing only a few dollars per error corrected, seems clearly economic. Its effectiveness may be judged in the one situation where there was a secondary review: The secondary review found focus or density errors in less than 0.2% (one in 500) of the reels reviewed. This corresponds to a technical quality, after review, of 99.8% error free.

5.3 The impact of quality on value

A computer engineer might suggest that the magnitude of a problem is related to the loss of meaning in the text. This concept will become important when and if text is automatically transformed from print into a stream of characters. The problem is very complex. For example, in the following excerpt from a telephone book:

Smith John B 322-4567
Smith John B 339-4327
Smith John B 452-7489

The first part of the middle line contains no information at all, while the four digits at the end of it cannot possibly be inferred from the context alone.

To estimate the impact of quality, which is largely defined in terms of optical characteristics of the film, rather than in its information content, we need to know much more than we do about how microfilm resources are (and will be) used, and about how much that use is impaired by deficiencies in the image. The engineer is probably in a poor position to sympathize with the problem. In engineering, the facts of an earlier era are preserved by incorporation into new texts and sources. It is the historian, as detective, who is most sensitive to the fact that the literature may give only one single clue to some important new line of research, much as the biologist may find only the faintest hint of a new virus after months of research.

In the next section we outline some problems of estimating the usage of microfilmed brittle books.

6. COST AND BENEFIT

6.1 A nominal unit cost

We may create a nominal unit cost for preparation and filming by selecting costs and rates within the ranges of data reported in Chapter 4. We choose the following (based on a 240 page book, which is the average size for the largest set of books for which we could compute an average).

Table 4. A NOMINAL UNIT LABOR COST FOR PRESERVATION MICROFILMING

Activity	Minutes	
(1) Decision/search	5.0	Some prof time (a)
(2)a. P x P collate	16.3	(240/14.7)
b. Disbind	2.0	min
(3) Record keeping	14.0	60% (1)-(2)
(4) Targets	8.0	
(5) Filming	30.0	240/(2x4 exp/min)
(6) Processing	10.8	17% of (5)+(6)+(7)
(7) Quality control	22.7	min/title (one library)
(8) Administration	38.08	nominal at 35% of cost of (1)-(7)
	146.9	

Note: (a) A few minutes of this time are professional, at higher salary. As discussed in Section 4.1, this does not include secondary review of the decision to film, in Preservation Microfilming offices.

To convert this to a cost we designate an hourly wage of $10/hour. This is higher than the data reported at the university libraries and lower than the data at the other libraries.

$$146.9/60 \times 10 = \$24.48$$

Since the process of microfilm preservation has the effect of adding a usable "books worth of information" to the collection this cost may be compared with the cost of adding a new volume to the collection. In a 1984 study by Tantalus, sponsored by the Council on Library Resources, these costs were found to be $8.40 + purchase price + cataloging.

Cataloging costs have not been included in the present study. For many preserved volumes, the original catalog entry does not meet current standards, so that essentially "original cataloging" (1984 cost: $22.46) is needed.

6.2 The time profile of benefit

Although research libraries must perform a vital archival function in an uncertain environment, much, if not all of the benefit attributable to a book or microfilm lies in its use by present or future scholars. At the most naive level one might simply divide the cost of acquisition by the expected lifetime use of the book. But, of course, the lifetime use cannot be defined.

If we turn, instead, to considering the expected use over the next 10 or 100 years we are again blocked by a lack of data. If the time span is very short, it is quite likely that a recently filmed book will not be used again at the library that filmed it. This would lead to a short-sighted decision not to film.

On the other hand, economic principles tell us that benefits accrued in the remote future should be discounted because they can be achieved by investing a smaller sum at the present time. If the benefits of library use are discounted it becomes more difficult to justify preservation, and even purchase.

6.3 The need to estimate demand

What is needed, for an economic discussion of the problem, is data on

(1) The level of current demand for brittle books, at the holding library

(2) The level of resource sharing demand, from other libraries, for positive prints

The first data can be gathered at any library, through a comparison of the proportions of brittle books in the collection and in current circulation.

The second can only be estimated from data on external requests versus microfilm holdings at major centers such as NYPL and LC. At present it is likely that demand is limited by limited awareness of the availability of materials. Thus computer networking and communication are likely to foster a strong increase in demand.

7. PROSPECTS FOR SAVINGS

7.1 Task cost savings

On the face of it, there are prospects for significant savings, for some libraries, in specific tasks including decision-making, target preparation, disbinding, filming and page checks. The improvements with greatest cost impact would be filming and page checks.

If key rates are replaced by the best rates found in this study, cost would drop as shown:

(1)	Decision	5.0	
(2)	P X P	16.3	
(3)	Records	14.0	
(4)	Targets	8.0	
(5)	Filming	20.0	@ 6 exp/min
(6)	Processing	10.8	
(7)	Quality Cont	17.3	Page check @ 21.9 p/min
(8)	Admin	38.1	
		131.5	

The savings is 15.4/146.9 = 10.5%. Combined with the nominal figure of $24.48 per volume this represents a savings of $2.56 per volume.

However, it is very hard to see how any small preservation operation can achieve these efficiencies. Skilled camera operators are acquired and trained over a span of years, and can only be retained with competitive salaries and job security.

As noted above, the best rate for page checks after filming is attributable to a combination of special skills and the fact that the film had already been checked and corrected once.

7.2 Savings in record keeping and administration

Record-keeping and administration together represent (14.0+38.1)/146.9 = 35% of total labor costs.

If record keeping could be reduced from 60% to 45% of preparation effort it would save a few minutes of the nominal time, but would produce a major saving for libraries with high record keeping expenses.

If administration were reduced from the nominal 35% to 24% of all other labor, there would be a savings of over 8% in the total cost.

Both of these kinds of savings have to do with management: management of information and management of people.

Together with the observations in the preceeding section this suggests that the most cost effective path for preservation microfilming is to concentrate preparation and filming into a small number of high volume centers. Most important is that the policies and procedures of that center be designed to control the costs of record keeping and of administration. If they are controlled at the outset, PM will be more effective as a tool for preserving deteriorating research collections.

Combining the estimate for task savings (10.5%) and administrative savings (at least 8%) we project potential savings of 18.5%, or $4.53 for the nominal volume. These savings can be achieved by maintaining a large operation, with a consistent labor force. This study has not addressed the costs of supplies, which are assumed to be uniform across the country, and the cost of equipment. All of the cameras and developers used in the labs studied are by now fully depreciated.

7.3 Savings in new technology

If a cooperative center is to be established, new cameras will be bought. This provides an opportunity to review the commitment to 35mm planetary camera technology that is more than 40 years old. With planetary camers, individual pages are placed on the filming table by hand. There is an alternative technology, now over 20 year old, which feeds paper automatically, and is called the rotary camera.

Rotary cameras are generally used in archival work, for filming standard size documents with text on one or both sides. At high reduction (40x) a rotary camera can film both sides of a sheet at once. The rotary camera is unsuited to the filming of bound books. The great majority of preservation microfilming, however, involves books that are disbound and later discarded. However, the brittle pages are likely to be damaged by the automatic feed, and their debris will affect the machine.

Both of these effects are evident in the data provided by the Ohio State University Archives, which has filmed eight volumes provided by three of the libraries. The work was done on a Kodak Reliant 550 camera, by a student operator with a few months experience. The results are shown in Table 5.

Table 5. PRODUCTION DATA FOR A ROTARY CAMERA.

Reduction	24x	40x
Pages	1837	1837
Exposures	1837	946
Time (min)	126	40 (a)
Exposures/min	14.6	23.7
Pages/min	14.6	47.3
Pages mended	14	11 (b)
Cleaning time (min)	10	10

Notes: (a) This includes the time required to clean the machine, during two cleaning breaks.

(b) All pages were filmed at 24x reduction first. Presumably, had the 40x reduction been done first, all of the pages that broke in the 24x run would have needed mending. Thus a more conservative estimate would be 25 mended pages out of 1837, or 1.4%. There would also be a slight corresponding increase in the total time required.

The libraries have agreed to review the quality (resolution, density and page by page checks) of these films. Their conclusions will be of great importance in planning for cooperative processing. If rotary cameras prove acceptable, the filming labor could be reduced by 15 min ($2.50) per book below our "best" estimate in Section 7.1.

8. Acknowledgements

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The study would not have been possible without the willingness of over one hundred individuals to step onto the economic microscope in hopes of benefitting the collective endeavor. At Tantalus, Dr. Jung Jin Lee designed the program that transforms random observations of individuals into profiles of effort and salary. Moula Cherikh reduced data on dozens of distinct subtasks into the eight broad categories used in this report. The final report was typed and produced by Paula Botkin.